# Gamma Ray and Neutron Detector Interactive

***Developer***: John Ristvey, McREL
***Audience:*** Grades 13-16, Professionals, General Public
***Format:*** Interactive diagram and Website

**Panel Recommendation:** Recommended for undergraduate students, graduate students and professionals in this field.

The Dawn dictionary requires medium revisions to be a useful component of this Website. Advanced words used in the interactive Website need to be included in the dictionary, and corrections to existing definitions in the Dawn dictionary are needed.

Comments and suggested revisions that could further improve this product are included in the individual review reports attached to this summary.

**Recommended Revisions**

**Missing Words:**

- The intended audience (grades 13-16 and the general public) need definitions for words and phrases such as: 'large ionic radius', 'neutron interactions', 'thorium tied up', 'epithermal', 'HED meteorites', 'diogenite', 'field programmable gate array', 'end members', 'scintillator' and 'metasilicate.'
- The ' pulse height spectrum' is not defined and is labeled differently in two pop-up spots on the diagram (the x-axis was labeled as the counts and counts/s/MeV).

**Dawn Dictionary:**

- The word "**Earth**" refers to a planet and should be capitalized throughout the dictionary.
- For the word: **Aphelion** - *The point in a planetary orbit that is at the greatest distance from the Sun* should be corrected to say that it's the point in ANY orbit that is farthest from the Sun.
- **Apparent Magnitude** - *The brightness of a star as it appears to the eye or to the telescope, as measured in units of magnitude—the brighter the star, the smaller the apparent magnitude.* This definition states that magnitude is measured in units of magnitude, which is a circular definition. "The brighter the star, the smaller the apparent magnitude" is misleading. Suggest something like "for brighter objects the value of the apparent magnitude is a smaller number."
- Suggest using the clarification "**Asteroid** - (also called a "**minor planet**")" instead of *"Asteroid (one type of minor planet)."* Minor planet need not be in quotes, since it is not a figure of speech or quotation.
- **Brightness** - *Refers to the amount of light coming from an object.* Suggest changing it to: The amount of light emitted, or reflected, by an object.
- **Chondrules** -*A crystallized sphere of rocky material found in chondrite meteorites. Named after the Greek for seeds, they are essentially tiny igneous rocks that formed in the solar nebula.* Reviewer thought CHON came from carbon, hydrogen, oxygen, and nitrogen. [IGES Note: the original definition appears to be correct. Source: "The New Solar System," Beatty, Petersen, and Chaikin, page 352. ]

- **Crust** - *The outer part of a planet, moon, or asteroid composed essentially of crystalline rocks—generally the crustal composition is different from the bulk composition of the planet (adapted from Merriam-Webster.com).* The crust/mantle boundary is determined from seismic wave velocities, at least for Earth. The lithosphere/aesthenosphere model of the rocky portion of a planet is a better model if you want to discuss a plastic/crystalline transition. Generally the crustal composition is different... for a differentiated object. Suggest making the definition of crust broader to include other bodies in the solar system.
- **Declination (DEC)** - *Declination is measured in degrees, and refers to how far above the "imaginary" celestial equator an object is (like latitude on the Earth).* Suggest rephrasing as how far above, *or below*, an object's position is relative to the celestial equator (and imaginary does not need to be in quotes, it is not a figure of speech).
- **Epicycle** - *Circular orbit of a body around a point that is itself in a circular orbit round a parent body—such a system was formulated to explain some planetary orbits in the Solar System before they were known to be elliptical.* Whether or not orbits are elliptical is irrelevant to the topic of epicycles -- they were used to explain retrograde motion.
- **Minor planet** - *(see **Asteroid**).* Objects like Sedna, Ixion, Orcas, Eris, etc. are minor planets as well. None of those are asteroids.
- **Rotation** - *Of a single body in space, spinning on an axis; of a planetary system, rotation is generally planar in relation to the parent star.* This is not generally true. In our Solar System, only a few planets don't have an appreciable tilt. The spin axis may be *expected* to be perpendicular to the system's invariable planet, but this does not happen often in the real world.
- **Theory** - *In science a theory is a verified hypothesis applicable to many related phenomena.* A theory is not necessarily verified. A theory is a generally accepted rule that has yet to be, or cannot currently be, verified. Relativity would be an example of this.

This product may be resubmitted at any time. Please include a list with your resubmission listing the revisions/changes made or a brief explanation of why a given revision would be inappropriate.

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Following is the summary of the individual reviews that was distributed to the reviewers prior to the panel discussion by telecon. This information was used to guide the panel discussion; it is included here to provide a complete report of the review process.

| **Reviewer** | **Overall Rating** | **Recommendation** |
|---|---|---|
| Postsecondary | Outstanding | Recommended |
| Postsecondary | Fair | Recommended, Limited Audience (Graduate students and professionals.) |
| Postsecondary | Good | Medium Revisions |
| Postsecondary | Fair | Medium Revisions |

**Strengths:**

- The product is relevant to NASA SMD planetary science education.
- The content is accurate and complete.
- Graphics are high quality and interesting.
- The dictionary was a good addition to the product (see notes in weaknesses below).
- The article contains references to journal articles that would be available to college students.
- The product is easy to use and free from technical difficulties.

**Weaknesses:**

- The product would be most useful for upper division majors (in astronomy, physics, geology, planetary science) or graduate students. Material describes a very specialized instrument and observation technique.
- Many difficult terms and words are not defined in the Dawn dictionary:
    - The intended audience (grades 13-16 and the general public) would need definitions of words and phrases such as: 'large ionic radius, 'neutron interactions','thorium tied up','epithermal','HED meteorites', 'diogenite','field programmable gate array','endmembers', 'scintillator', and 'metasilicate (in the dictionary).'
    - The ' pulse height spectrum' is not defined and is labeled differently in two pop-up spots on the diagram (the x-axis was labeled as the counts and counts/s/MeV).
- One reviewer identified a number of issues in the Dawn dictionary. See the *Dawn Dictionary* section below for a listing of suggested changes and clarifications. This reviewer offered to work with developers to improve the dictionary.
- In hotspot 6, the figures are interchanged. The top figure is CZT and the bottom is BGO. Figure c is described before figure b.
- In the pop-up for the gamma rays, the phrase 'Eucrite and Diogenite' should be 'Eucrites and Diogenites.' The second paragraph in this pop-up is a run-on sentence.
- The first paragraph in the pop-up box for 'Thermal and epithermal neutrons' is a run-on sentence.
- It is not clear how this product would be used in the classroom (i.e. would it be assigned as a homework reading assignment or a classroom demonstration).
- The site does not include a text version of the audio file for 508 accessibility requirements.

- The initial 'footprint' animation can be missed if users don't scroll down fast enough. The page needs to be refreshed to show this animation again.
- One reviewer did not understand why the diagram was called a 'SPLAT diagram.'
- The link between this instrument and the Dawn mission goals was not clear.

**Additional Comments/Suggestions:**

- Suggest describing who Harrison Schmidt was [IGES note: He was the final astronaut to set foot on the moon and has been the only geologist to visit another body in the solar system].
- Suggest changing the aspect ratio of the Website so material fits the width of the browser. The forced size and black edges make the site harder to use.
- One reviewer commented that different methods of interaction with the SPLAT diagram could confuse users (some information points on the diagram are activated by hovering the mouse and some are activated by left clicking). Three of the clickable hotspots are the same (the three gamma rays).
- Suggest making the content of the pop-up areas downloadable or printable.
- When users print the article, much of the page is blank and the font is very small making it difficult to read. Suggest modifying the PDF file to use more space by using larger fonts.
- Pop-up information mentions science goals at Vesta, HED meteorites and Ceres, but the differences between these targets is not discussed. It is not clear why these objects were targeted for this technique.
- In the GraND Overview pop-up window, the text does not define eV. Suggest a conversion to joules and a definition of the term use.
- Content of the article (by Tom Prettyman) beyond section 3 does not pertain to this product. Suggest removing later sections.

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